

The Importance of Engine Oil Quality for the Automotive Industry



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Author:

Reinhard Bütchorn, GMPT-E Base Engine Lubrication Systems

The Importance of Engine Oil Quality for the Automotive Industry

Content:

- Drivers for high Performance Engine Oils
- ACEA Sequences
- OEM Inhouse Specifications / GM Specs.
- Impact on Engine Oil / Practical Examples
- Summary



Drivers for High Performance Engine Oils

Continuous improvement of engine oil for modern High Tech-engines ensures:

- Long-Term Engine Durability
- Long Drain Intervals
- Emission Legislation Compliance
- Fuel Economy
- Fuel Quality Compatibility
- And Enables New Engine Technology
 - Cam Phaser, Multiple T/C's, Supercharger-T/C



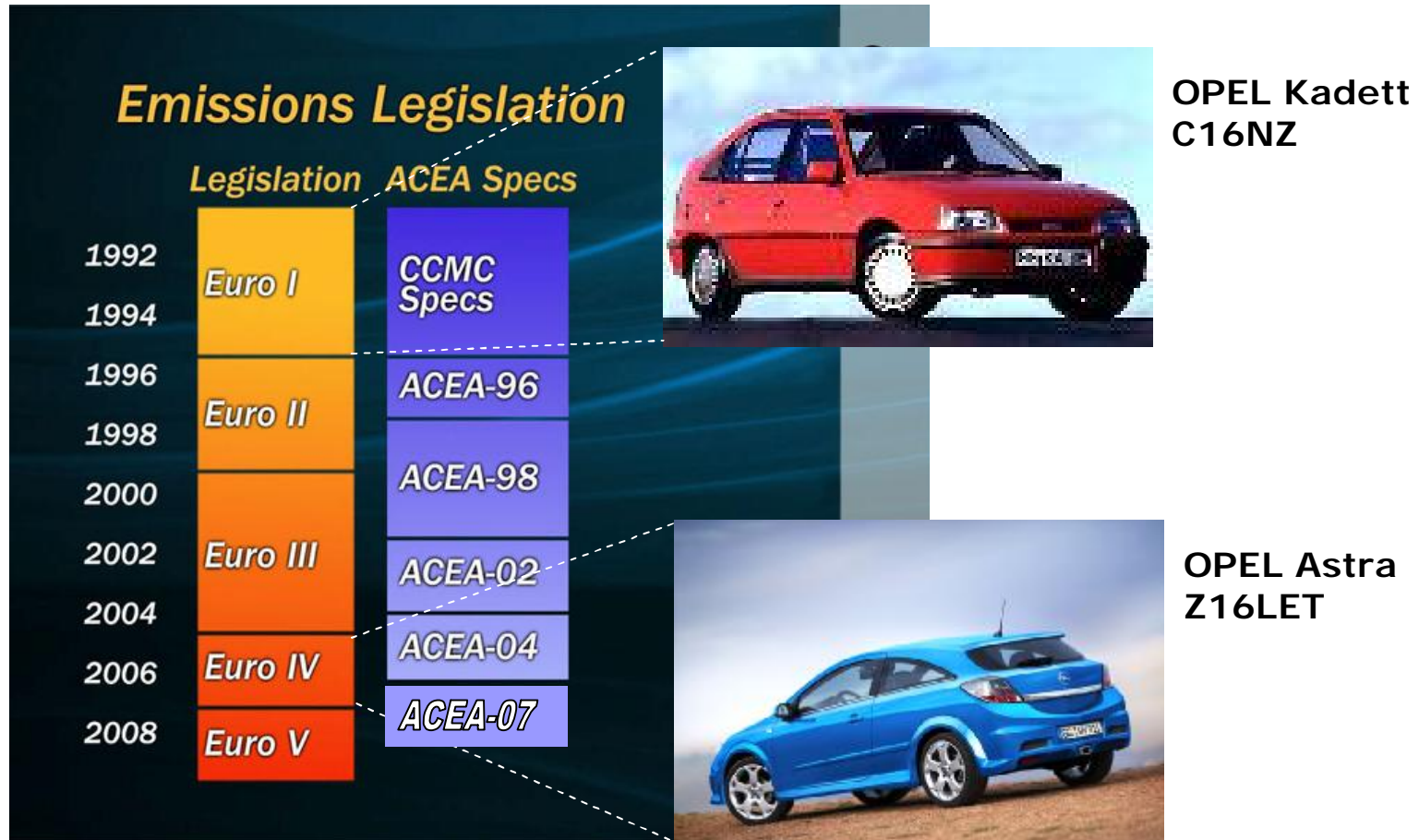
Drivers for high Performance Engine Oils

Increased Customer Expectations (e.g. Opel Compact Vehicle)

	1991 E-Kadett	2000 Astra	2008 Astra
Engine Type	C16 NZ	X16XE	Z16LET
Power [KW]	55	77	132
Power Density [KW/L]	34	48	83
Max.Velocity [km/h]	150	180	221
Max. Oiltemp. [°C]	120	130	140
Oil Volume [L]	3,5	3,5	4,5
Change Interval	5 kkm/ 6 months	15 kkm/ 1 year	max. 30 kkm/ 1 year



Emission/Oil Spec Comparison



OEM Members/Brands represented in ACEA

Brands covered, e.g.:



ACEA WGFL

Pass. Cars/"Light Duty" Group:

- BMW
- Ford Europe
- GM Europe
- PSA (Peugeot-Citroen)
- Porsche
- Renault
- Volkswagen
- Volvo

WGFL Subgroup
Lubricants

OEM Members

- meeting frequently
- maintaining/updating specs



Engine Tests in ACEA Oil Specifications

Gasoline	Test Aspect	Engine Type
• TU5	High Temp Deposit	1,6 MPFI L4
• SEQ VG	Low Temp Sludge	4,6 V8
• TU3M	Cam Wear	1,4 SPI L4
• M111	Black Sludge	2,0 MPFI L4
• M111	Fuel Economy	2,0 MPFI L4
<u>Diesel</u>		
• DV4TD	Medium Temp Dispersivity	1,4 L4 DI TC
• VW DI	Piston Cleanliness, Ring Stick	1,9 L4 DI TC/IC
• OM602A*	Engine Wear, Oil Consumption	2,5 L5 IDI TC

* will soon be replaced by OM 646, 2,2 L4 Common Rail DI TC/IC

MPFI = Multi Port Fuel Inj., SPI = Single Point Inj., TC = Turbo charged, IC = Intercooled



ACEA 2007 – LD Tests & Requirements Summary

	A1/B1-04	A3/B3-04	A3/B4-04	A5/B5-04	C1-04	C2-04	C3-07	C4-07
HTHS	2.9 to 3.5	> 3.5	> 3.5	2.9 to 3.5	≥ 2.9	≥ 2.9	≥ 3.5	≥ 3.5
Noack	≤ 15	≤ 13	≤ 13	≤ 13	≤ 13	≤ 13	≤ 13	≤ 11
Sulphated ash	≤ 1.3	≤ 1.5	≤ 1.6	≤ 1.6	≤ 0.5	≤ 0.8	≤ 0.8	≤ 0.5
Sulphur	report	report	report	report	≤ 0.2	≤ 0.3	≤ 0.3	≤ 0.2
Phosphorus	report	report	report	report	≤ 0.05	0.07 to 0.09	0.07 to 0.09	≤ 0.09
Chlorine	report	report	report	report	report	report	report	report
TBN	-	-	-	-	-	-	≥ 6	≥ 6
TU3M	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass
Sequence VG	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass
M111SL-AES	≥ RL 140	≥ RL 140	≥ RL 140	≥ RL 140	≥ RL 140	≥ RL 140	≥ RL 140	≥ RL 140 +45 or > 9.0
M111FE	≥ 2.5	-	-	≥ 2.5	≥ 2.5	≥ 2.5	≥ 1.0 for xW-30	≥ 1.0 for xW-30
VW ICTD - Piston cleanliness	≥ RL 148	≥ RL 148	-	-	-	-	-	-
OM602A - Cam wear	≤ 50.0	≤ 50.0	≤ 50.0	≤ 50.0	≤ 50.0	≤ 50.0	≤ 45.0	≤ 45.0
KV Increase	≤ 90.0	≤ 90.0	≤ 90.0	≤ 90.0	≤ 90.0	≤ 90.0	≤ 70.0	≤ 70.0
Bore polish	≤ 7.0	≤ 7.0	≤ 7.0	≤ 7.0	≤ 7.0	≤ 7.0	≤ 4.5	≤ 4.5
Cylinder wear	≤ 20.0	≤ 20.0	≤ 20.0	≤ 20.0	≤ 20.0	≤ 20.0	≤ 15.0	≤ 15.0
TDI - Piston cleanliness	-	-	≥ RL206 - 3pts	≥ RL206	≥ RL206	≥ RL206	≥ RL206	≥ RL206
Ring sticking	-	-	≤ 1.2/2.5/0.0	≤ 1.2/2.5/0.0	≤ 1.2/2.5/0.0	≤ 1.2/2.5/0.0	≤ 1.2/2.5/0.0	≤ 1.2/2.5/0.0
OM646LA	may be used at an equivalent performance level to the OM602A when the test becomes available as a CEC test							





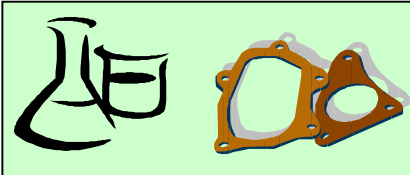


OEM Inhouse Engine Oil Specifications

- Industry oil standards like ACEA, API are result of compromises
- Requirements are not fully tailorable to individual OEM needs like:
 - Long drain capability
 - Enhanced Fuel Economy
 - Backwards Compatibility (Aftersales Requirement)
 - Universal Oil (one oil for Gasoline, Diesel, CNG, LPG, Hybrids)
 - Compatibility with specific aftertreatment systems (DPF, NOx storage catalyst etc.)
 - Applicability for various fuel qualities (E85, B20 etc.)



GME Engine Oil Specification Approach

Inhouse on top		Engine tests: Inhouse
		Compatibility: Inhouse elastomer tests
		Chem.-physical: Inhouse requirements
Basis		Engine tests: Industry Standard (ACEA , API)
		Chem.-physical: Standard tests Compatibility: Standard elastomers



Example: GME Engine Oil Specification

Oil quality		GM-LL-A-025	GM-LL-B-025
PHYSICAL - CHEMICAL REQUIREMENTS			
Requirements	Method		
High Temperature High Shear Viscosity (HTHS)	CEC L-36-A-90, ASTM D4741	≥ 2.9 mPa.s	≥ 3.5 mPa.s
Viscosity Classification Service Fill	SAE J300	0W-30, 5W-30, 0W-40, 5W-40	0W-30, 5W-30, 0W-40, 5W-40
Evaporation Loss (Noack)	CEC L-40-A-93, ASTM D5800/ A	≤ 11.5 wt%	≤ 11.5 wt%
Total Base Number	LBCH02-14	> 10.5 mg KOH/g	> 9.0 mg KOH/g
Sulphur	DIN 51 400-10, ASTM D4951 (ICP) EN ISO 14596, ASTM D2622 (XRF)	< 0.5 wt%	< 0.5 wt%
Sulfated ash	DIN 51 575, ASTM D874	≤ 1.6 wt%	≤ 1.6 wt%
Foaming Tendency / Stability	Sequence I, II, III (24 + 94°C), ASTM D892	PASS	PASS
HT Foaming Tendency	Sequence IV (150°C) ASTM D6082	PASS	PASS
Shear Stability	CEC L-14-A-93	PASS	PASS
ELASTOMER TESTS			
Elastomer Compatibility, ACEA	CEC-L-39-T-96, VDA 675301	Elastomer Types: RE1 (FPM), RE2-99 (ACM), RE3-04 (VMQ), RE4 (NBR), AEM	Elastomer Types: RE1 (FPM), RE2-99 (ACM), RE3-04 (VMQ), RE4 (NBR), AEM
Elastomer Compatibility, GM	GME 60 255	Elastomer Types: VQM, FPM, NBR, ACM	Elastomer Types: VQM, FPM, NBR, ACM

Standard Test & Requirement: ACEA

Test or Requirement:

GM Inhouse



Example: GME Engine Oil Specification

Oil quality		GM-LL-A-025	GM-LL-B-025
ENGINE TESTS			
High Temperature Deposits, Ring Sticking, Oil Thickening	Peugeot TU5JP-L4, CEC L-88-T-02	ACEA A3/ B4 PASS	ACEA A3/ B4 PASS
Low Temperature Sludge	Sequence VG, ASTM D6593	ACEA A3/ B4 PASS	ACEA A3/ B4 PASS
Black Sludge	MB M 111 , CEC L-53-T-95	ACEA A3/ B4 PASS	ACEA A3/ B4 PASS
Valve Train, Scuffing Wear	Peugeot TU3MS, CEC L-38-A-94	ACEA A3/ B4 PASS	ACEA A3/ B4 PASS
Fuel Economy	M 111 vs. RL191 (15W-40), CEC-L-54-T-96	GME 8331TP (vehicle roller bench) $\geq 1.5\%$	-
Ring Sticking, Piston Cleanliness	VW 1.6L TC Diesel Intercooler, CEC-L-46-T-93	ACEA A3/ B4 PASS	ACEA A3/ B4 PASS
Medium-Temp. Dispersivity	DV4TD CEC-L-093	ACEA A3/ B4 PASS	ACEA A3/ B4 PASS
DI Diesel Piston Cleanliness, Ring Sticking	VW DI, CEC L-78-T-99	ACEA A3/ B4 PASS	ACEA A3/ B4 PASS
Wear, Viscosity Stability, Oil Consumption	OM646LA, Draft CEC-L-099 (until available alt. OM602A)	ACEA A3/ B4 PASS	ACEA A3/ B4 PASS
Oil Release Test Gasoline Engines OP1	GM PTE-T DUR020	PASS	-
Aeration Test	GM PTE-T MEC024	PASS	PASS
Valve train wear test (RNT)	GM PTE-T DUR021	PASS	-
Oil Release Test Diesel Engines	GM PTE-T DUR019	-	PASS

Standard Test & Requirement: ACEA

Test or Requirement: GM Inhouse



GME Engine Oil Aftersales Releases

- Prerequisite for elongated Oil change intervals
- Supports Opel/GME Quality strategy
- Introduction in January 2002

GM-LL-A-025: 80 approvals

- Gasoline engines from MY '02,5
- max. 30.000 km/1 year Oil change
- HTHS > 2.9 $\bar{\omega}$ not backwards compatible

GM-LL-A / B-025 combined: 68 approvals

- All Gasoline & Diesel engines from MY '02,5
- And backwards compatible

GM-LL-B-025: 143 approvals

- Diesel engines from MY '02,5
- max. 30.000 km/1 year Oil change
- HTHS > 3.5 $\bar{\omega}$ backwards compatible

Summarized:

- 155 approvals
- thereof 132 Re-brands & Re-blends



Example: GM Global Engine Oil

Working Title	GEOSA	GEOSB
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Specification

PHYSICAL - CHEMICAL REQUIREMENTS

Requirements	Method		
High Temperature High Shear Viscosity (HTHS)	CEC L-36-A-90, ASTM D4741	xW-20 ≥ 2.6 mPa·s xW-30 ≥ 2.9 mPa·s	≥ 3.5 mPa·s
Viscosity Classification Service Fill	SAE J300	0W-20, 5W-20, 0W-30, 5W-30	0W-30, 5W-30, 0W-40, 5W-40
Evaporation Loss (Noack)	CEC L-40-A-93, ASTM D5800/ A	≤ 13.0 wt%	≤ 13.0 wt%
Total Base Number	DIN ISO 3771, ASTM D 2896	≥ 6.0 mg KOH/ g	≥ 6.0 mg KOH/ g
Ball Rust Test	ASTM D 6557	100 min	100 min
Sulphur	DIN 51 400-10, ASTM D4951 (ICP) EN ISO 14596, ASTM D2622 (XRF)	≤ 0.4 wt%	≤ 0.3 wt%
Phosphorus	DIN 51 363-3, ASTM D4951 (ICP) DIN 51 363-2, ASTM 6443 (XRF)	≤ 0.08 wt%	0.070 - 0.090 wt%
Sulfated ash	DIN 51 575, ASTM D874	≤ 1.0 wt%	≤ 0.8 wt%
Chlorine	ISO 15597 (XRF)	< 150 ppm	< 150 ppm
Foaming Tendency / Stability	Sequence I, II, II (24 + 94°C), ASTM D892	ILSAC GF-4 & ACEA C3-07 PASS	ILSAC GF-4 & ACEA C3-07 PASS
HT Foaming Tendency	Sequence IV (150°C) ASTM D6082	ILSAC GF-4 & ACEA C3-07 PASS	ILSAC GF-4 & ACEA C3-07 PASS
Shear Stability	Bosch Injector, CEC L-14-A-93	stay in grade	stay in grade
Corrosion Performance Factory Fill only	LBCH02-45 [ISO 6270-2, AHT & prep]	0 (no corrosion)	0 (no corrosion)

ELASTOMER TESTS

Elastomer Compatibility	ACEA: CEC-L-39-T-96, VDA 675301 SAE: ASTM D7216	Elastomer Types: ACEA: RE-1 (FPM), RE-4 (NBR), AEM SAE J2643: ACM-1, VMQ-1, HNBR-1	Elastomer Types: ACEA: RE-1 (FPM), RE-4 (NBR), AEM SAE J2643: ACM-1, VMQ-1, HNBR-1
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Standard Test & Requirement: **ACEA** **API**

Test or Requirement: **GM Inhouse**



Example: GM Global Engine Oil

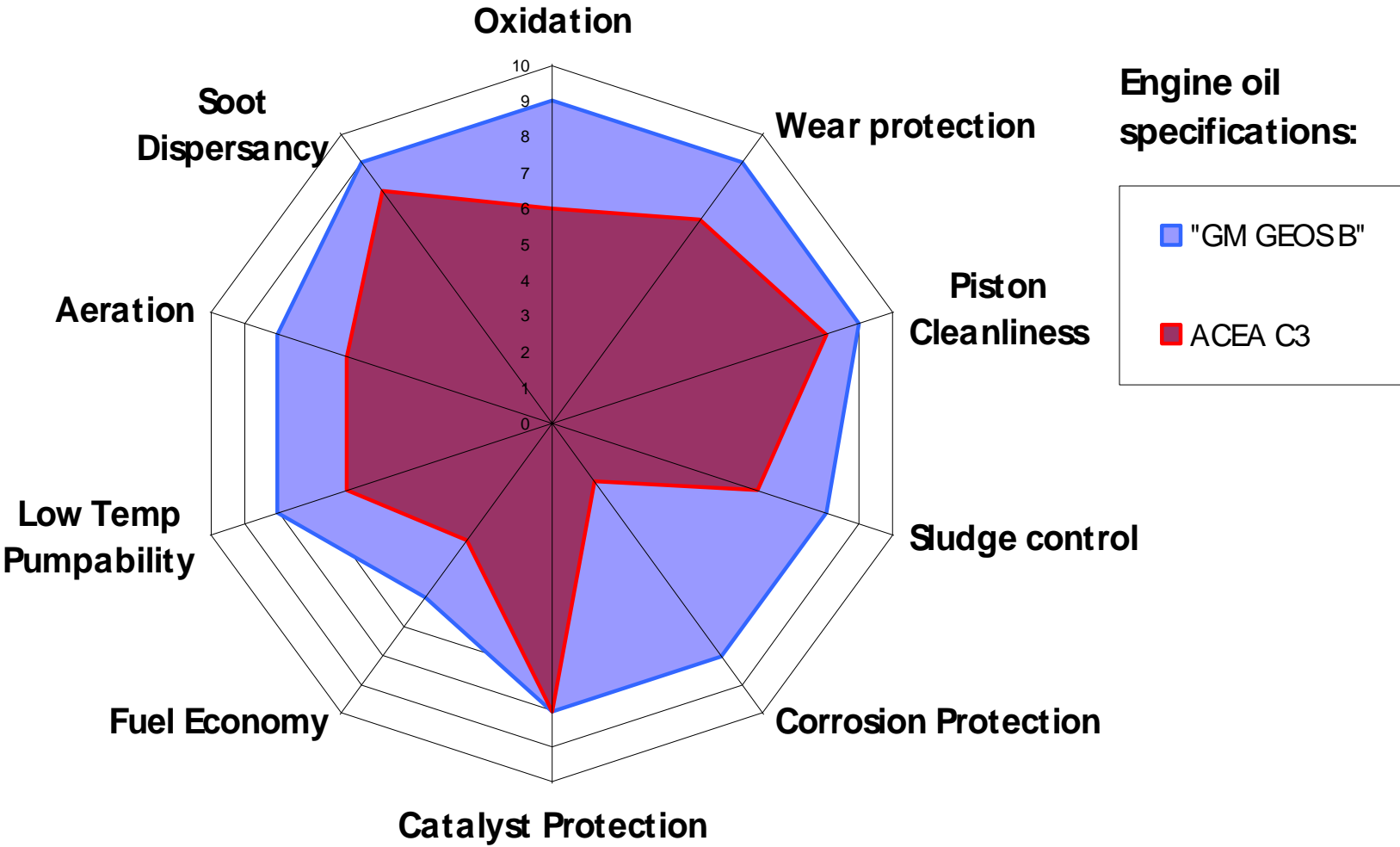
Working Title		GEOSA	GEOSB
Specification			
ENGINE TESTS			
High Temperature Deposits, Ring Sticking, Oil Thickening	Peugeot TU5JP-L4, CEC L-88-T-02	ACEA C3-07 PASS	ACEA C3-07 PASS
Black Sludge	MBM 111, CEC L-53-T-95	ACEA C3-07 PASS	ACEA C3-07 PASS
Valve Train, Scuffing Wear	Peugeot TU3MS, CEC L-38-A-94	ACEA C3-07 PASS	ACEA C3-07 PASS
Fuel Economy	M 111 vs. RL191 (15W-40), CEC-L-54-T-96	rate & report	≥ 2.0 %
Medium-Temp. Dispersivity	DV4TD CEC-L-093	-	ACEA C3-07 PASS
DI Diesel Piston Cleanliness, Ring Sticking	VW DI, CEC L-78-T-99	-	ACEA C3-07 PASS
Wear, Viscosity Stability, Oil Consumption	OM646LA, Draft CEC-L-099 (until available alt. OM602A)	-	ACEA C3-07 PASS
Bearing Corrosion	Sequence VIII, ASTM D6709	ILSAC GF-4 PASS	ILSAC GF-4 PASS
High Temperature Deposits, Ring Sticking, Oil Thickening	Sequence IIIG / IIIGA	ILSAC GF-4 PASS (higher weighted piston deposits limit)	ILSAC GF-4 PASS (higher weighted piston deposits limit)
Low Temperature Sludge	Sequence VG, ASTM D6593	ILSAC GF-4 & ACEA C3-07 PASS (with higher sludge & clogging limits)	ILSAC GF-4 & ACEA C3-07 PASS (with higher sludge & clogging limits)
Fuel Economy, long term	Sequence VIB, ASTM D6837	ILSAC GF-4 PASS	-
Oil Release Test Gasoline Engines	GM PTE-T DUR020	PASS	PASS
Aeration Test	GM PTE-T MEC024	PASS	PASS
Valve train wear test (RNT)	GM PTE-T DUR021	PASS	PASS
Oil Release Test Diesel Engines	GM PTE-T DUR019	-	PASS

Standard Test & Requirement: ACEA **API**

Test or Requirement: GM Inhouse

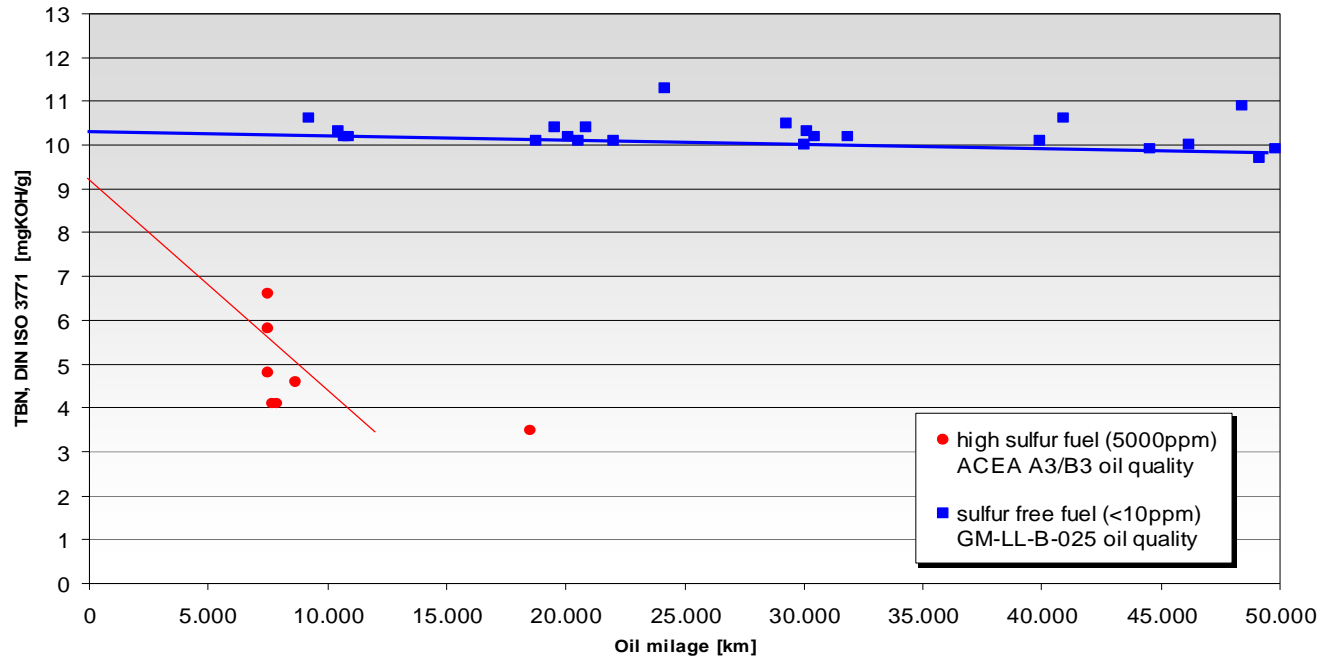


Generic Performance comparison



Impact of oil & fuel quality

TBN decrease dependent on fuel & oil quality
 Low vs. High sulfur fuel in DI Diesel engines



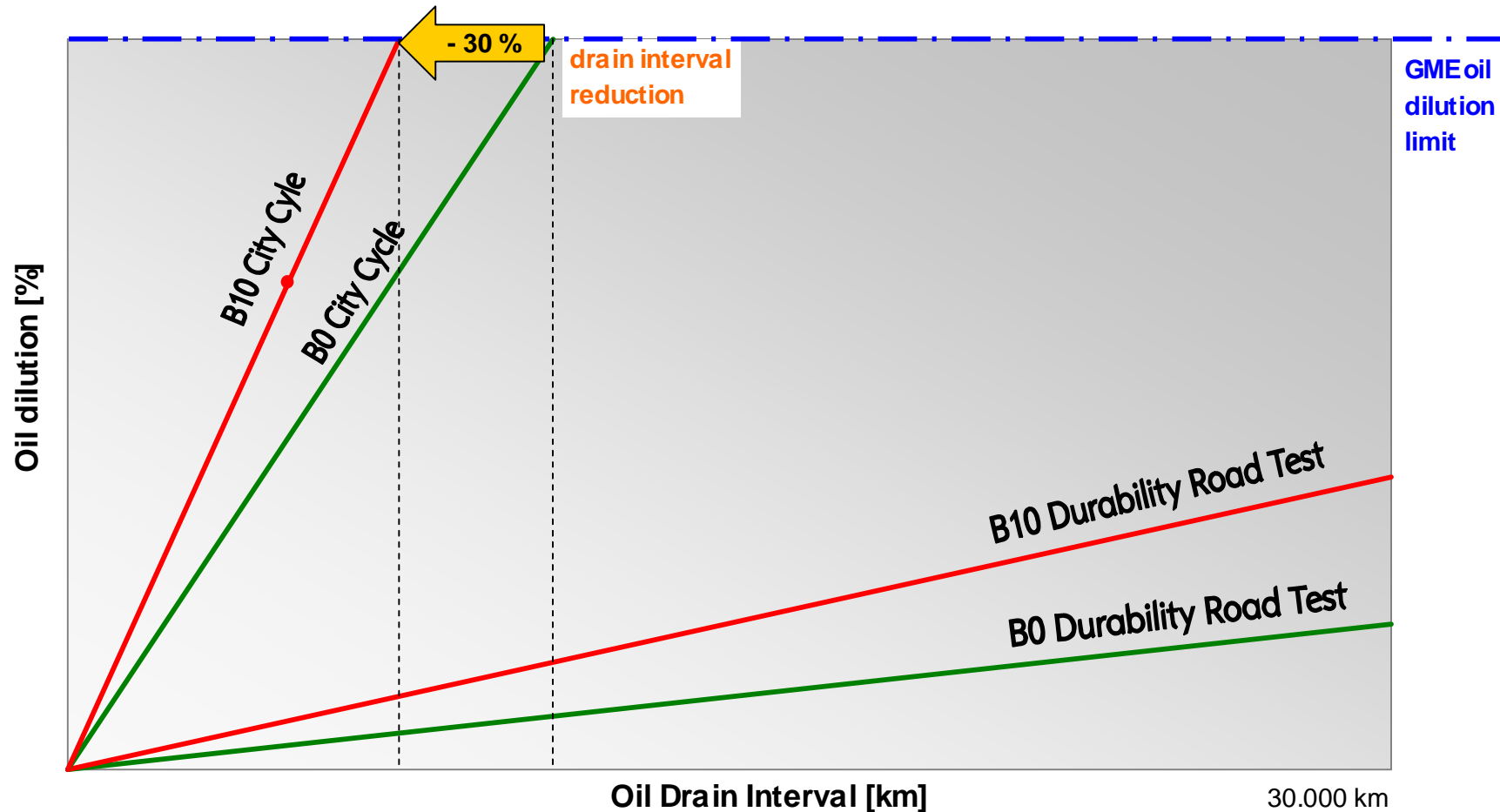
- **Lower oil and fuel quality in export countries requires compensation by reduced oil change intervals**

Oil change Interval Gasoline engine			Oil change Interval Diesel engine	
EU	Export		EU	Export
30.000 km / 1 yr	15.000 km / 1 yr	7.500 km / 1 yr	30.000 km / 1 yr	15.000 km / 1 yr
GM-LL-A-025	ACEA A3/B3	API SM / ILSAC GF-4	GM-LL-B-025	ACEA A3/B4



Impact of Biodiesel: Example B10

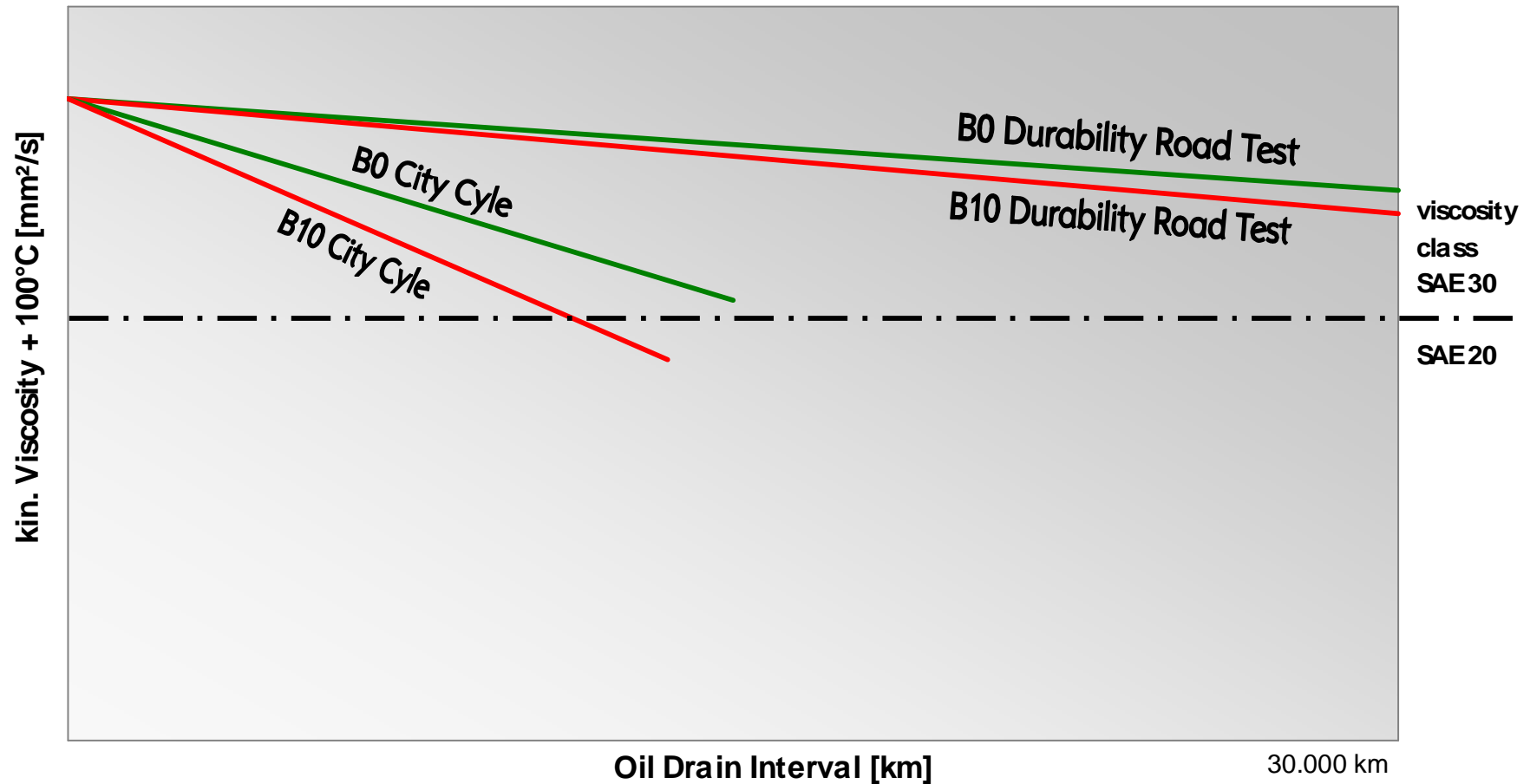
Engine oil dilution, Example Zafira Z19DTH
Impact of driving conditions & Fuel quality on Oil Drain Interval



Impact of Biodiesel: Example B10

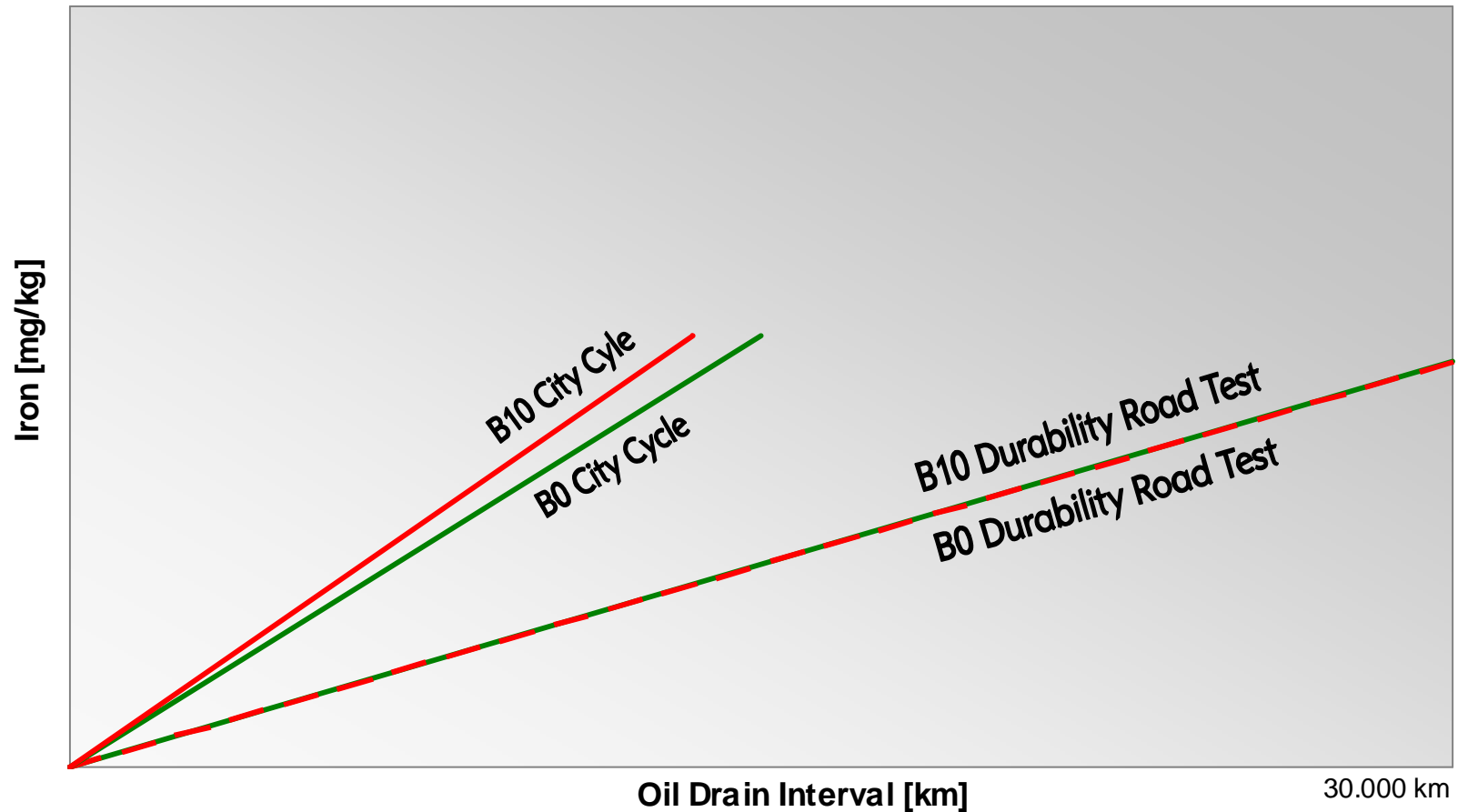
Viscosity +100°C, Example Zafira Z19DTH

Impact of driving conditions & Fuel quality on Viscosity Change



Impact of Biodiesel: Example B10

Iron content, Example Zafira Z19DTH
Impact of driving conditions & Fuel quality on Wear



The Importance of Engine Oil Quality for the Automotive Industry

Summary

- High performance engine oils are key enabler for development of high tech engine
- for Europe, ACEA sequences are baseline for OEM's
- continuous evolution is actively supported by ACEA, ATIEL and ATC
- OEM's use In-house specs to address additional needs on top of ACEA sequences



The Importance of Engine Oil Quality for the Automotive Industry

Summary, cont'd.

- Globalization will demand world wide harmonized engine oil specifications, e.g. GM “GEOS A / B” specifications
- Fuel economy, emission requirements and compatibility with alternative fuels are main drivers for future development of optimized engine oil performance
- Support of mineral oil-, additive industry and independent test labs is prerequisite and acknowledged by OEM's



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Many thanks for your attention!